Smart Atlas for Supporting the Interpretation of needle-based Confocal Laser Endomicroscopy (nCLE) of Pancreatic Cysts: First Classification Results of a Computer-Aided Diagnosis Software based on Image Recognition

Marzieh Kohandani Tafreshi, Bertrand Napoléon, Anne-Isabelle Lemaistre, Marc Giovannini, Virendra Joshi, Julien Dauguet, Nicholas Ayache, Barbara André

Smart Atlas for Supporting the Interpretation of needle-based Confocal Laser Endomicroscopy (nCLE) of Pancreatic Cysts: First Classification Results of a Computer-Aided Diagnosis Software based on Image Recognition

Marzieh Kohandani Tafreshi, Bertrand Napoléon, Anne-Isabelle Lemaistre, Marc Giovannini, Virendra Joshi, Julien Dauguet, Nicholas Ayache, Barbara André

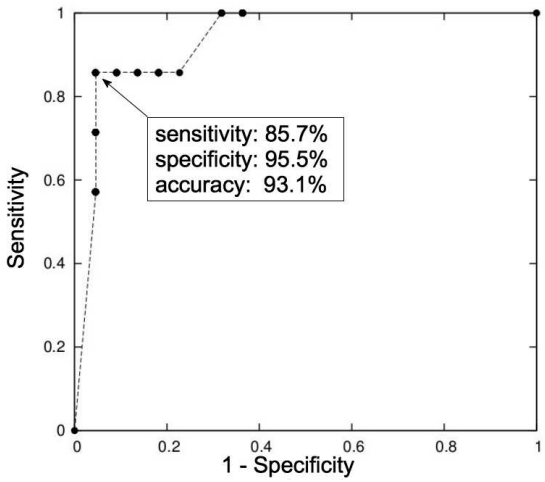
BACKGROUND AND AIMS:
nCLE enables microscopic imaging of pancreatic cysts, in vivo and in real time, during an EUS-FNA procedure. Differentiating branch duct-type Intraductal Papillary Mucinous Neoplasm (IPMN) and Serous Cystadenoma (SCA) of the pancreas can be difficult, especially in case of a solitary lesion without clear communication with the pancreatic duct. Recent studies (Konda et al., Endoscopy 2013; Napoléon et al., DDW 2013) have identified reliable nCLE descriptive features (superficial vascular network in SCA; finger-like projections in IPMN), allowing endoscopists to discriminate between SCA and IPMN. In parallel, a computer-aided diagnosis software called Smart Atlas has been developed to assist endoscopists with the interpretation of nCLE video sequences. This study aims at evaluating the performance of this software for the differentiation of SCA and IPMN cases.

METHODS:
Several nCLE sequences, of proven SCA or IPMN, were retrospectively collected from nCLE procedures performed in multiple clinical centers. These video sequences, along with their annotated final diagnosis, were used to train a classification software that uses a content-based image retrieval algorithm to predict the diagnosis of a query video based on the diagnoses of the most visually similar atlas videos. All evaluations were performed using leave-one-patient-out cross-validation to avoid bias. To reduce the number of unnecessary surgeries with high morbidity rates, false positives were minimized on a receiver operating curve.

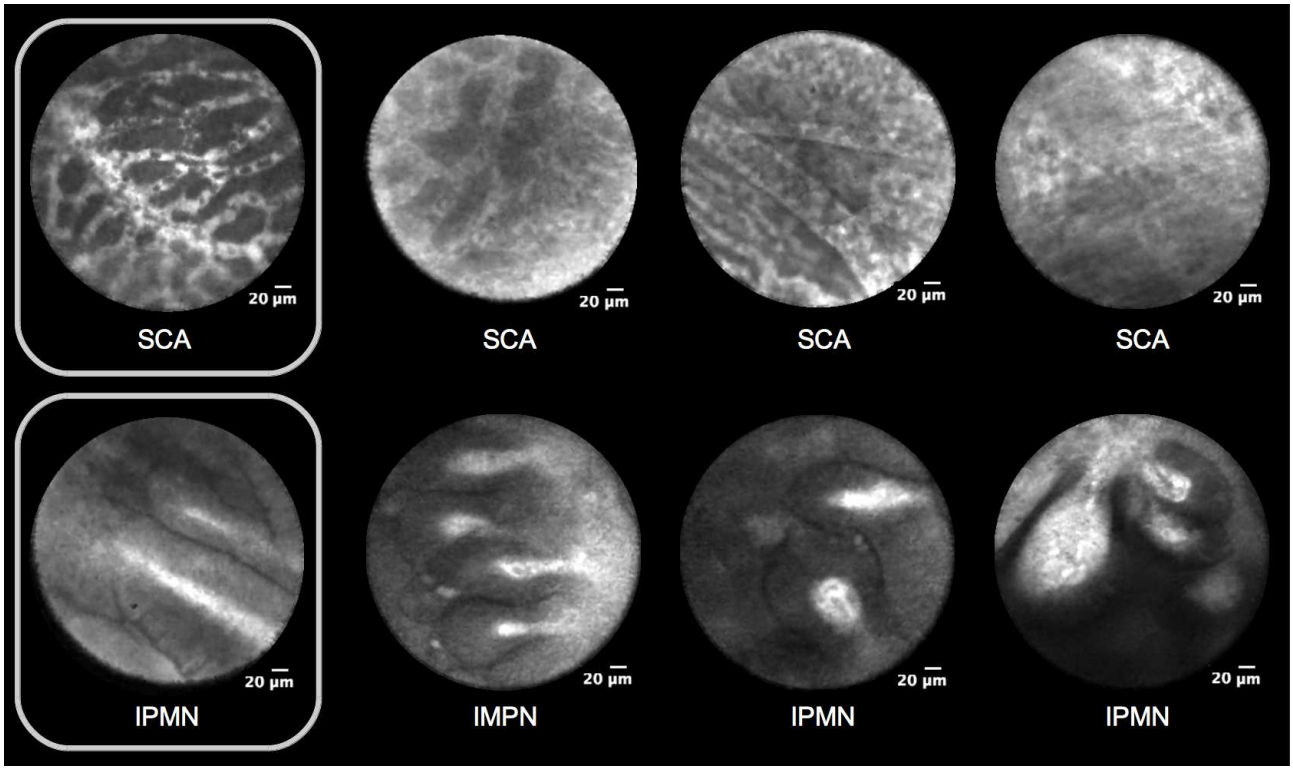
RESULTS:
29 nCLE video sequences were collected from 18 patients, with one lesion per patient (12 SCA, 6 IMPN), leading to 22 sequences annotated with SCA and 7 sequences annotated with IPMN. The classification results maximizing the specificity for an acceptable sensitivity show a specificity of 95.5% for a sensitivity of 85.7%, an accuracy of 93.1%, a PPV of 85.7% and a NPV of 95.5%, with only one false positive and one false negative. In comparison, Napoléon et al. reported that the performance achieved by a consensus of investigators on retrospective data to differentiate SCA from all other types of lesions reaches a specificity of 100% for a sensitivity of 62.5%.

LIMITATIONS:
Small and unbalanced sample size.

CONCLUSIONS:
These first results demonstrate that the Smart Atlas software is able to differentiate SCA and IPMN cases using only the image content of nCLE sequences, with very high specificity and rather high sensitivity. Besides, the case-based reasoning software can detect relevant video content and provide diagnostic confidence levels. It could thus be used as an educational tool to train non-expert endoscopists, but also as a second-reader tool to assist any user in real-time diagnosis of pancreatic cysts using nCLE. Future software improvements will leverage a larger sample size, various types of cysts and clinical metadata.



Receiver operating characteristic curve for the binary classification between SCA and IPMN pancreatic cysts.



On each line: nCLE image representative of a query video (framed image on the left), followed by 3 nCLE images representative of the 3 atlas videos which have been automatically recognized by the Smart Atlas software as the most visually similar to the query video. Each nCLE video is annotated with final diagnosis.